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# Geographic information — Classification Systems - Part 1, Classification system structure

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# Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 191xx-1 was prepared jointly by the UN Food and Agriculture Organization and Technical Committee ISO/TC 211, *Geographic information/Geomatics* under a cooperative agreement between the two organizations. Elements of this document are also available as part of a UN FAO specification ISBN: 92-5-105327-8 © FAO 2005 and ISBN 92-5-104216-0 © FAO 2000.

# Introduction

This International Standard defines structure for a classification system represented as discrete coverages together with the mechanism of defining and registering classifiers. This is part 1 of a set of standards related to classification systems. Other parts in the series define specific classification systems related to particular application areas, such as the UN FAO Land Cover Classification System (LCCS) described in Part 2. Since there are many different possible application areas there is no single classification system that will serve all needs. The method by which classifiers are defined depends upon the application area. In addition the classifiers used within a particular application area may not be adequate for all situations encountered within that application area and may need to be augmented over time. To facilitate extension of the set of classifiers in a particular application area, classifiers are registered in an ISO 19135 *Geographic information— Procedures for registration of items of geographic information,* compliant register structure. This allows the set of classifiers to be maintained. The use of the ISO 19135 registration mechanism allows for separate registers to be defined for different sets of classifiers within multiple information communities to satisfy application needs. This approach allows for the independence between information communities, but also allows relationships to be developed between different classification systems that potentially allow the conversion, or partial conversion, of data from one classification system to another, or the fusion of data from two separate sources.

The concept of classification systems is well known in the geographic information community. A classification system permits any geographic area to be subdivided into small units each of which carries an identifier that describes its type. This mechanism corresponds to the Discrete Coverage as described in ISO 19123 *Geographic information -- Schema for coverage geometry and functions*. Many such classification systems can be defined to address any geographic area. Different application areas and different information communities may define their own classification systems. However, if the classification system is defined in a compatible way it is possible to interwork between different information communities. In addition, in a particular application area, it is desirable that there be a few well-established classification systems, that themselves are standardized within information communities. This multi-part standard describes both the common structure in Part 1, and allows for the standardization of specific classification systems in the subsequent parts. The UN FAO LCCS is identified as an information community described classification system in Part 2.

A coverage is a function that returns values from its range for any direct position within its spatial, temporal, or spatiotemporal domain. A discrete coverage is a function that returns the same feature attribute values for every direct position within any single spatial object, temporal object, or spatiotemporal object in its domain. The domain is an area covered by the coverage function, and the discrete coverage breaks that area down into a set of spatial, temporal, or spatiotemporal objects. The geometry of the discrete coverage used for a classification system may either be a set of polygons fitted together like a jig-saw puzzle, or a set of grid cells.

In a classification system the range of attributes for a discrete coverage are established by a set of classifiers. The classifiers may be algorithmicly defined, or defined according to a set of classification system specific rules. These classifiers are application area dependent and are defined in the other parts of this multi-part standard, or in other external specifications or standards. A register allows for the maintenance of a set of classifiers for a particular application area. A spatial object, temporal object, or spatiotemporal object defined in terms of a set of classifiers is a classification object.

There is a commonality between conventional geographic features and classification objects. A feature is defined in ISO 19110 *Geographic information -- Methodology for feature cataloguing,* as an abstraction of real world phenomena. An example of a class of feature is a "building", and a particular building, such as the UN building in New York, is an instance of a feature class. Conventional geographic features are atomic units that are assembled to build one type of geographic information data set. A classification system works in the opposite manner, from the top down, by successively decomposing the whole within a coverage area. Classification objects are features in that they are an abstraction of a real world phenomena, but classification objects are not atomic in that they are necessarily related to each other by the classifiers that decompose the whole.  In a simple example of a classification system the earth as a whole can be covered by either "land" or "water", and two classifiers can be defined partitioning the attribute range into two, identifying objects as being either land or water. Any particular area on the earth, corresponding to a classification object, would be of type "land" or "water".

This International Standard defines schemas for registers conformant to ISO 19135 *Geographic Information – Procedures for registration of geographic information items*. ISO 19135 specifies that a technical standard is required to define the item classes in any conformant register. This International Standard serves as the technical standard that defines the item classes required for the registration of classifiers.

A register of classifiers establishes the set of rules or parameters to drive rules that may be used in a particular context to establish classification objects.

Registers of classifiers may serve as sources of reference for similar registers established by other geographic information communities as part of a system of cross-referencing. Cross-referencing between respective items in registers of classifiers may be difficult in cases where the structure of registers differ between information communities. This International Standard may serve as a guide for different information communities to develop compatible registers that can support a system of classifier cross-referencing.

This standard is derived in part from the LCCS - Land Cover Classification System specification developed by the Food and Agricultural Organization of the United Nations. - Ref: [1] and Ref: [2].

# Geographic information — Classification Systems - Part 1, Classification system structure

## 1 Scope

This International Standard specifies the structure for a classification system represented as discrete coverages together with the mechanism of defining and registering classifiers. This structure permits the development of other parts to this standard that address specific classification systems. This standard also defines the technical structure of a register of classifiers in accordance with ISO 19135 *Geographic information — Procedures for registration of items of geographic information*.

## 2 Conformance

### 2.1 Classes

Two conformance classes are identified for this International Standard.

### 2.2 Conformance of a classification system

Any classification system that claims conformance to this International Standard shall satisfy all of the conditions specified in the following Abstract Test Suites:

a) ISO 19123 for general conformance [ISO 19123, Annex A.2.1 Discrete coverage interchange], and

b) Annex A.2 of this International Standard.

### 2.3 Conformance of a register of classifiers

Any register of classifiers that claims conformance to this International Standard shall satisfy all of the conditions specified in the following Abstract Test Suites:

a) ISO 19135 for general conformance [ISO 19135, Annex A.1], and

b) Annex A.3 of this International Standard.

## 3 Normative references

ISO/IEC 19501:200x—[1)], *Information technology — Unified Modeling Language (UML)*

ISO 19107:—, *Geographic information— Spatial schema*

ISO 19109:—, *Geographic information— Rules for application schema*

ISO 19111:—, *Geographic information— Spatial referencing by coordinates*

ISO 19115:—, *Geographic information— Metadata*

ISO 19123:—[1], *Geographic information— Schema for coverage geometry and functions*

ISO/TS 19129:—[1], *Geographic information— Imagery, Gridded and Coverage Data Framework*

ISO/TS 19126:—[1], *Geographic information— Profile FACC Data Dictionary*

ISO 19135:—[1], *Geographic information— Procedures for registration of items of geographic information*

# 4 Terms, definitions, and abbreviations

## 4.1 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply.

**4.1.1**
**classification object**
A spatial object, temporal object, or spatiotemporal object defined in terms of a set of classifiers

**4.1.2**
**classification system**
a scheme where the range of attribute for a discrete coverage are a set of classifiers

**4.1.3**
**classifier**
definition or rule that may be used in a particular context to partition the attribute space of a discrete coverage to establish a classification object

Note: Classifiers may be algorithmicly defined, or defined according to a set of classification system specific rules.

**4.1.4**
**coverage**
**feature** that acts as a **function** to return values from its **range** for any **direct position** within its spatial, temporal, or **spatiotemporal domain** [ISO 19123]

EXAMPLE Examples include a **raster** image, polygon overlay, or digital elevation matrix.

NOTE In other words, a coverage is a feature that has multiple values for each attribute type, where each direct position within the geometric representation of the feature has a single value for each attribute type.

**4.1.5**
**discrete coverage**
**coverage** that returns the same **feature attribute** values for every **direct position** within any single **spatial object**, temporal object, or **spatiotemporal object** in its **domain** [ISO 19123]

NOTE The domain of a discrete coverage consists of a finite set of spatial, temporal, or spatiotemporal objects.

**4.1.6**
**discriminated feature**
a general **feature** combined with a **discrimination attribute** [ISO 19126]

1) To be published.

NOTE A discriminated **feature** is more specialized than the original **feature**.

**4.1.7**
**discrimination attribute**
**feature attribute** whose value acts as a type discriminator for a **feature** [ISO 19126]

EXAMPLE **Feature attribute** ‘building function’ with **attribute listed value** ‘lighthouse’ may be used together to discriminate the type of a general ‘building’ **feature**.

**4.1.8**
**domain**
well-defined set [ISO/TS 19103]

NOTE Domains are used to define the domain and **range** of operators and **functions**

**4.1.9**
**feature**
abstraction of real world phenomena [ISO 19110]

EXAMPLE The phenomenon named “Eiffel Tower” may be classified with other similar phenomena into a feature type named “tower”.

NOTE A feature may occur as a type or an instance. In this International Standard, feature type is meant unless otherwise specified.

**4.1.10**
**feature attribute**
characteristic of a **feature** [ISO 19110]

**4.1.11**
**identifier**
linguistically independent sequence of characters capable of uniquely and permanently identifying that with which it is associated [ISO 19135]

**4.1.12**
**item class**
set of items with common properties [ISO 19135]

NOTE Class is used in this context to refer to a set of instances, not the concept abstracted from that set of instances.

**4.1.13**
**range**
<coverage>
set of **feature attribute** values associated by a **function** with the elements of the **domain** of a **coverage** [ISO 19123]

**4.1.14**
**register**
set of files containing **identifiers** assigned to items with descriptions of the associated items [ISO 19135]

**4.1.15**
**registry**
information system on which a **register** is maintained [ISO 19135]

**4.1.16**
**technical standard**
standard containing the definitions of **item classes** requiring registration [ISO 19135]

### 4.2 Abbreviations

| | |
|---|---|
| UNFAO | United Nations Food and Agriculture Organization |
| LCCS | Land Cover Classification System (also used by the UNFAO for the UNFAO Land Cover Classification System) |
| UML | Unified Modeling Language |

## 5 Classification Systems

### 5.1 Concept of a classification system

A coverage function is a function that returns one or more feature attributes for any direct postion within its spatiotemporal domain. A coverage is a single entity, a subtype of a feature, that carries a set of attribute values dirtributed over a spatiotemporal domain. Coverages and coverage functions are described in ISO 19123 and the relationship of coverages to metadata and other aspects of imagery, gridded and coverage data is described in ISO/TC 19129.

Coverages may either be contineous or discrete. Contineous coverages make use of interpolation to provide intermediate values between a set of data values that drive the function. An example of contineous coverage is illustrated in ISO/TC 19129 Figure 1.

A discrete coverage returns the same feature attribute for every direct position within any single geometric object in its spatiotemporal domain. The spatiotemporal domain consists of a set of geometric objects that together form the coverage. An example of a discrete coverage would be the postal zones within a country. Each zone would have a different code and it is not possible to interpolate between these codes. Nevertheless there may be a high level relationship between the codes. For example the small country of Monaco is divided into five parts "Moneghetti", La Condamine", "Fontvieille", "Monaco-Ville", and "Monte-Carlo". These political jurisdictions completely cover the area of the country. The area of Monaco can be represented as a discrete coverage with five spatial objects where each object has the geometry of a polygon. The attribute for each spatial object would be the name of the political juristiction. See Figure 1

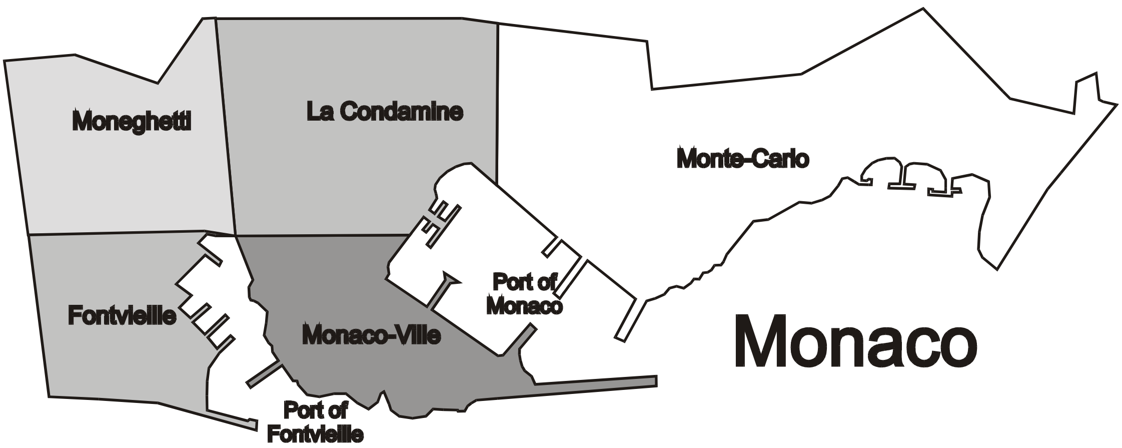


**Figure 1 – An Example Discrete Coverage with Polygon Geometry**

The geometry of the spatial objects associated with a discrete coverage may also be grid cells within a grid structure. Each of the grid cells may carry an attribute describing some characteristic such as vegetation type. This is illustrated in Figure 2. A legend is also shown in Figure 2, which identifies the instances of the attribute values that actually exist in the data.

 

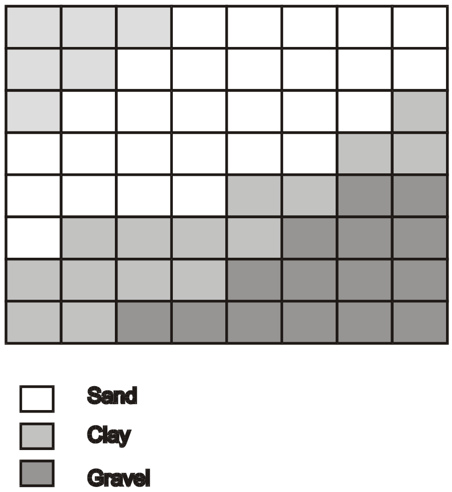


**Figure 2 – An Example Discrete Coverage with Grid Geometry**

The discrete coverages illustrated above are simple because only relatively simple attributes have been used. However in real cases the attributes for each of the coverage spatial objects can be very complex. In order to describe land cover it is necessary to integrate a large number of descriptive parameters related to soil, biology, and density into a comprehensive land cover classification system. Such a classification system is of course application area dependent. An oceanographer would have a different classification system than a meterologist. Classification systems can vary widely in different application areas, but for similar application areas there needs to be some commonality in order to be able to use data from different sources together.

A classification system allows one to define "classifiers" in order to partition the attribute range of a discrete coverage to establish classification objects.

## 5.2 Classification and Legend

*Classification* is an abstract representation of real world phenomena (i.e. the situation in the field) using well-defined diagnostic criteria: the classifiers (see Figures 3 and 4). Sokal (1974) defined it as: "the ordering or arrangement of objects into groups or sets on the basis of their relationships." - Ref [3]. A classification describes the systematic framework with the names of the classes and the criteria used to distinguish them, and the relation between classes. Classification thus necessarily involves definition of class boundaries that should be clear, precise, possibly quantitative, and based upon objective criteria.

A classification system should therefore be:

- *Scale independent,* meaning that the classes at all levels of the system should be applicable at any scale or level of detail; and

- *Source independent,* implying that it is independent of the means used to collect information, whether satellite imagery, aerial photography, field survey or some combination of them is used.

A *legend* is the application of a classification in a specific area using a defined mapping scale and specific data set (Figure 5). Therefore a legend may contain only a proportion, or sub-set, of all possible classes of the classification. Thus, a legend is:

- *Scale and cartographic representation dependent* (e.g., occurrence of mixed mapping units if the elements composing this unit are too small to be delineated independently); and

- Data and mapping methodology dependent (e.g., an aerial photograph shows different features compared to a satellite false colour composite image).

A legend is a selection of a set of the classifiers from all of the possible classifiers within a classification system. This is analogeous to the set of features within a feature catalogue, which is a subset of all of the possible features within a feature data dictionary. A legend may correspond to the classifiers that apply to a single data set or it may be applicable to a number of related data sets.

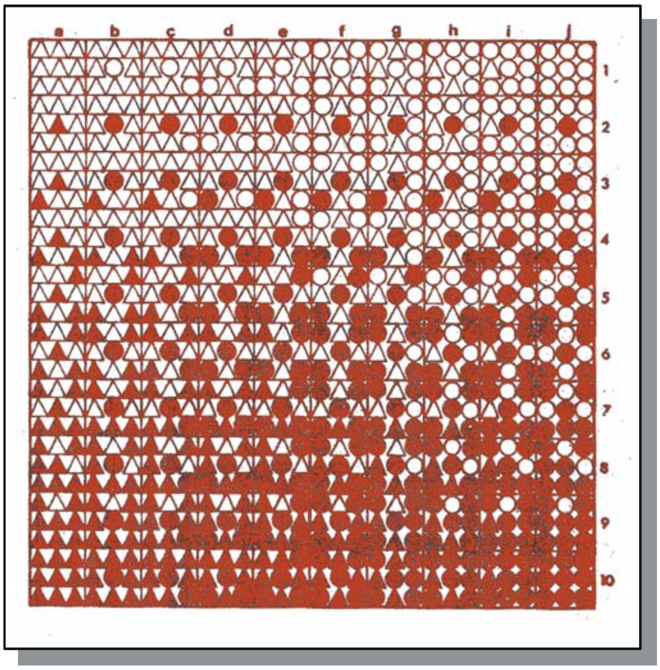


**Figure 3 – Abstract presentation of a classification consisting of a continuum with two gradients: circles and triangles in red and white representing the concrete situation in the field - (From Kuechler and Zonneveld, 1988).**

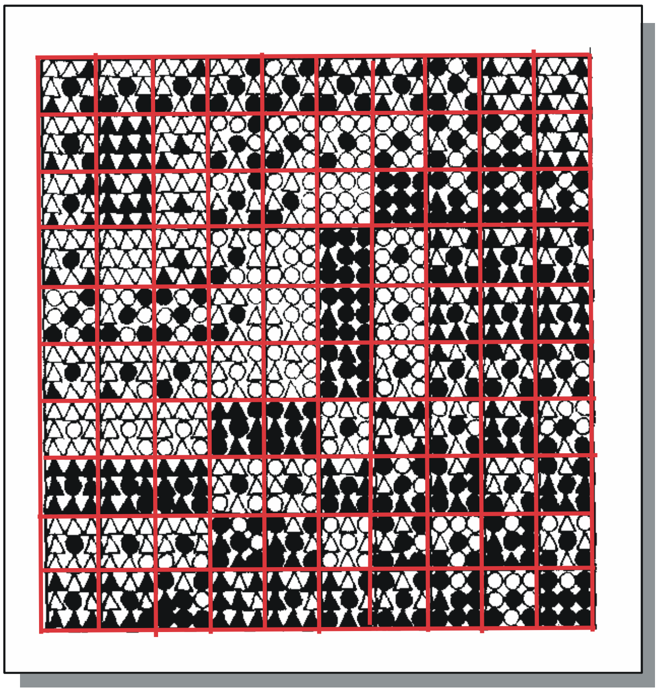

**Figure 4 – Concrete situation in the field in a particular area (From Kuechler and Zonneveld, 1988).**

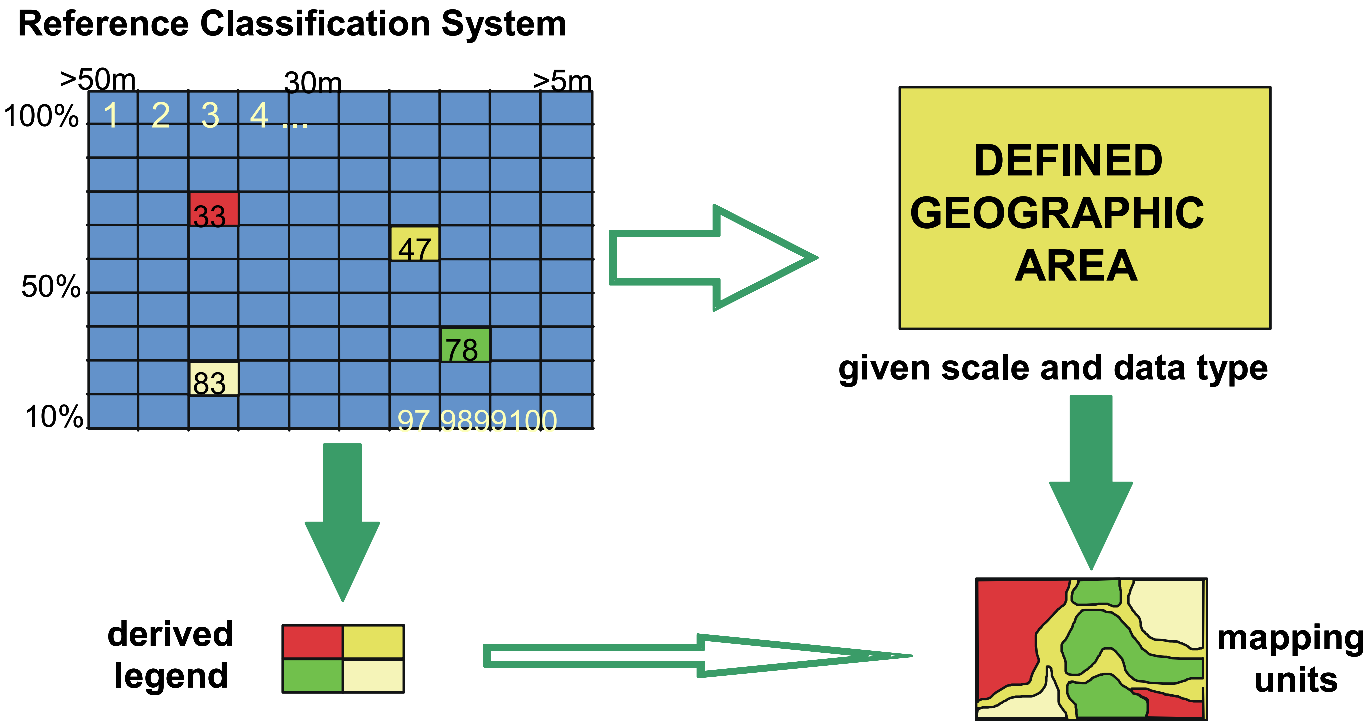


**Figure 5 – Legend as an application of a classification in a particular area (From UN FAO LCCS)**

### 5.3 Hierarchical versus non-hierarchical systems

Classification systems come in two basic formats, hierarchical and non-hierarchical. Most systems are hierarchically structured because such a classification offers more consistency owing to its ability to accommodate different levels of information, starting with structured broad-level classes, which allow further systematic subdivision into more detailed sub-classes. At each level the defined classes are mutually exclusive. At the higher levels of the classification system few diagnostic criteria are used, whereas at the lower levels the number of diagnostic criteria increases. Criteria used at one level of the classification should not be repeated at another, i.e., lower, level

### 5.4 A PRIORI and A POSTERIORI Systems

Classification can be done in two ways; that is, either *a priori* or *a posteriori* (Figure 6). In an *a priori* classification system the classes are abstractions of the types actually occurring. The approach is based upon definition of classes before any data collection actually takes place. This means that all possible combinations of diagnostic criteria must be dealt with beforehand in the classification. This method is used extensively in plant taxonomy and soil science (e.g., The Revised Legend of the Soil Map of the World (FAO, 1988) - Ref: [5] and the USDA Soil Taxonomy (United States Soil Conservation Service, 1975)) - Ref: [6]. The main advantage is that classes are standardized independent of the area and the means used. The disadvantage, however, is that this method is rigid, as some of the field samples may not be easily assignable to one of the pre-defined classes.

*A posteriori* classification differs fundamentally by its direct approach and its freedom from preconceived notions. The approach is based upon definition of classes after clustering similarity or dissimilarity of the field samples collected. The Braun-Blanquet method, used in vegetation science (this is a floristic classification approach using the total species combination to cluster samples in sociological groups (Kuechler and Zonneveld, 1988)) - Ref: [4], is an example of such an approach. The advantage of this type of classification is its flexibility and adaptability compared to the implicit rigidity of the *a priori* classification. The *a posteriori* approach implies a minimum of generalization. This type of classification better fits the collected field observations in a specific area. At the same time, however, because an *a posteriori* classification depends on the specific area described and is adapted to local conditions, it is unable to define standardized classes. Clustering of samples to define the classes can only be done after data collection, and the relevance of certain criteria in a certain area may be limited when used elsewhere or in ecologically quite different regions. Although the *a posteriori* approach to classification cannot pre-define standardized classes, it can establish standardized rules for establishing classes.

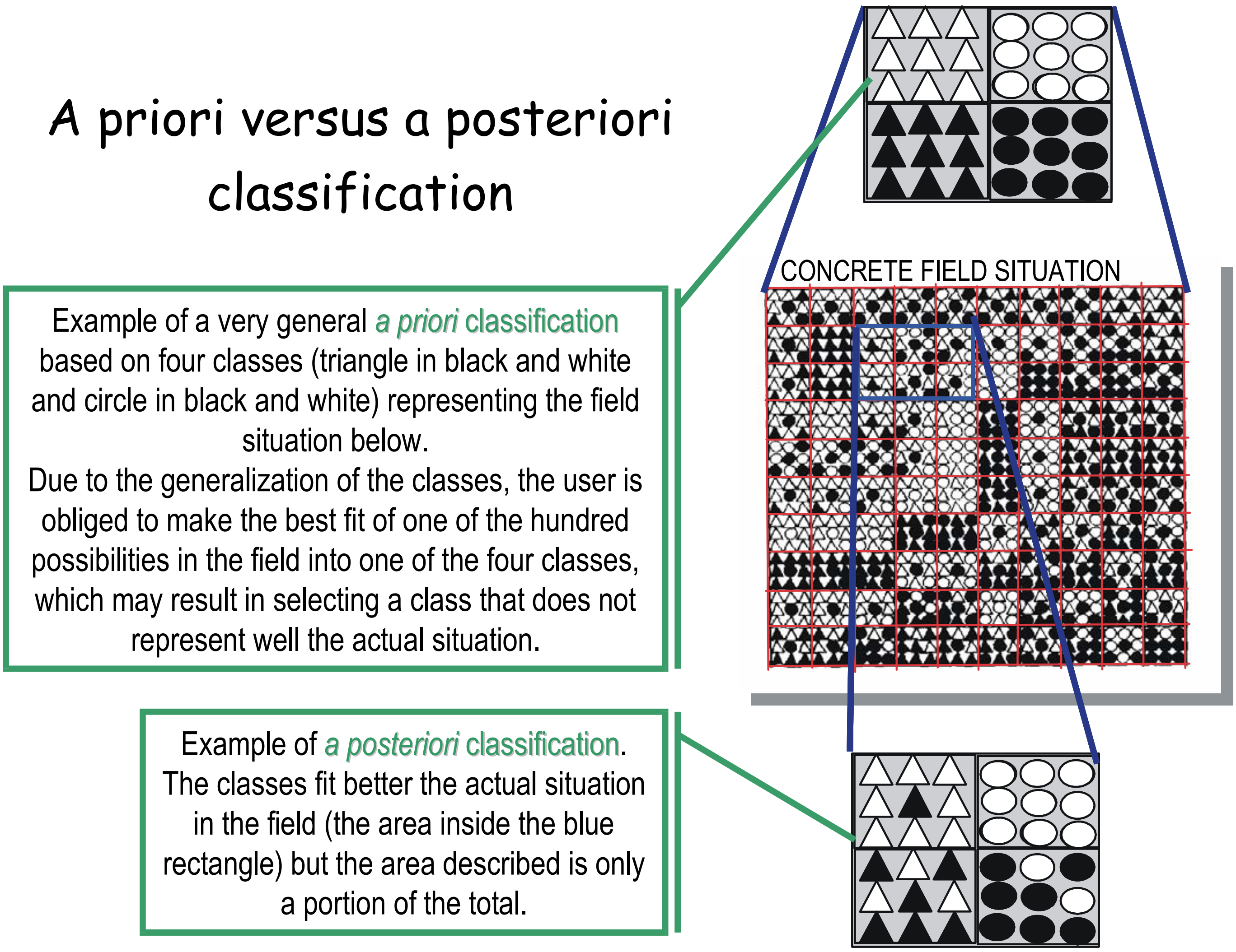


**Figure 6 – Example of an a priori (above) and a posteriori (below) classification related to a concrete situation in the field (adapted from Kuechler and Zonneveld, 1988).**

### 5.5 Structure of classified data

A classified data set is a type of discrete coverage. Coverages are described in ISO 19123 and in the OGC Abstract Specification -Ref: [7]. The range of a discrete coverage is a set of feature attribute values represented as a set of records with a common schema defined by the classification system. The domain that consists of a finite collection of classification objects together with their direct positions. The geometric object and its associated record form a geometry value pair.

 

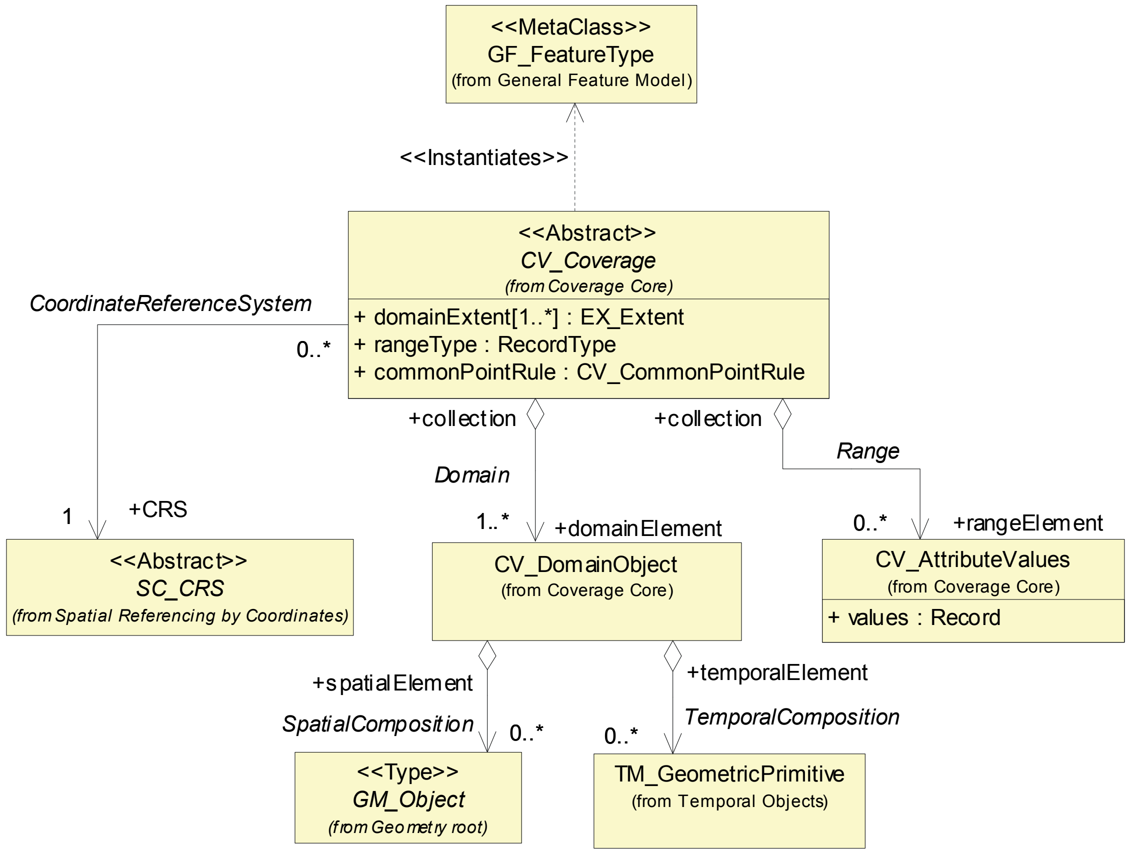


**Figure 7 – Elements of a coverage**

The class CV_Coverage (ISO 19123) represents a feature type in accordance with the general feature model from ISO 19109. This is illustrated in Figure 7. The class CV_Coverage has three attributes, the domainExtent, the *rangeType* and the *commonPointRule*. The *commonPointRule* is used in the evaluation of contineous coverages. In discrete coverages there is a direct one to one relationship where each CV_GeometryValuePair. The attribute *domainExtent* describes the extent of the domain coverage. The data type EX_Extent is defined in ISO 19115. The attribute *rangeType* describes the structure and composition of the attribute data record.

Associated to a CV_Coverage is a specification of the Coordinate Reference System to which the objects in the domain are referenced. The coordinate reference system is defined in ISO 19111.

Also associated with the CV_Coverager are the CV_Domain and the CV_AttributeValues. The set of domain objects is linked to the corresponding set of data records corresponding to the attribute values. A CV_DomainObject may be any spatial or temporal or spatio-temporal object. A discrete coverage comprised of a set of polygons covering its domain would make use of GM_Object (ISO 19107). A discrete coverage composed of grid cells would make use of CV_GridPoint (ISO 19123). There is one instance of CV_AttributeValues (i.e one data record) for each instance of CV_DomainObject (i.e. each grid cell or polygon area).

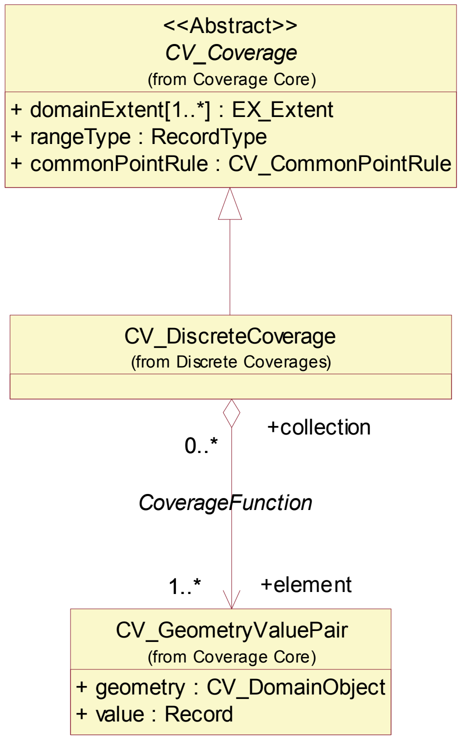


**Figure 8 – Elements of a discrete coverage**

CV_DiscreteCoverage is the subclass that returns the same record of feature attribute values for any direct position within a single CV_DomainObject in its domain. Each geometry value pair consists of a domain object (e.g. a grid cell or a polygon) and a record of feature attribute values. See Figure 8.

The type of a discrete coverage is based on the type of geometric object in the spatial domain. Clause 6 of ISO 19123 identifies five types of discrete coverage with different geometries. These are:

- a discrete point coverage - consisting of a set of independent points
- a grid point coverage - consisting of a set of grid cells
- a discrete curve coverage - consisting of a set of curves
- a discrete surface coverage - consisting of a set of surfaces. Typically these are GM_Surface objects (polygons), but they may also be TIN objects or Thiessen Polygon objects.
- a discrete solid coverage - consisting of a set of solid volumes

A classification system may make use of any type of geometric object in its spatial domain; however, the two most common types are GM_Surface (polygon) and grid cells represented in a CV_GridValuesMatrix.

A classification system based on a set of polygons (GM_Surface) will make use of the CV_Discrete surface coverage described in clause 6.8 of ISO 19123. The use of GM_Surface as the geometry element is illustrated in Figure 9.

 

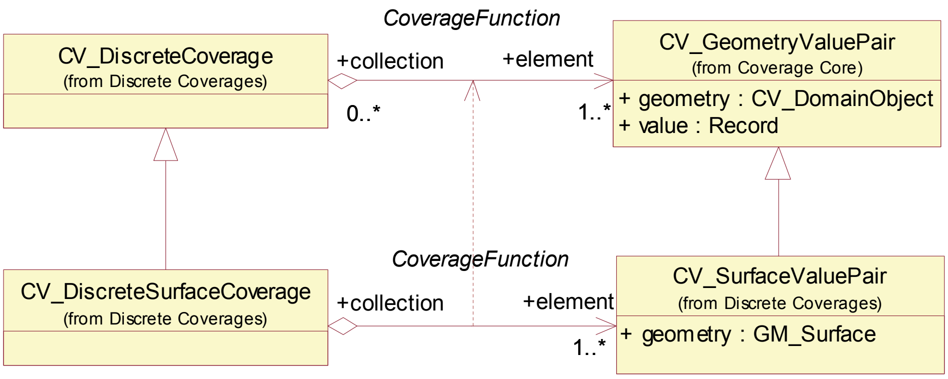


**Figure 9 –Discrete surface coverage**

A classification system based on a grid coverage will make use of the CV_Discrete grid point coverage described in clause 6.4 of ISO 19123. The use of CV_GridPoint corresponding to a CV_GridCell as the geometry element is illustrated in Figure 10.

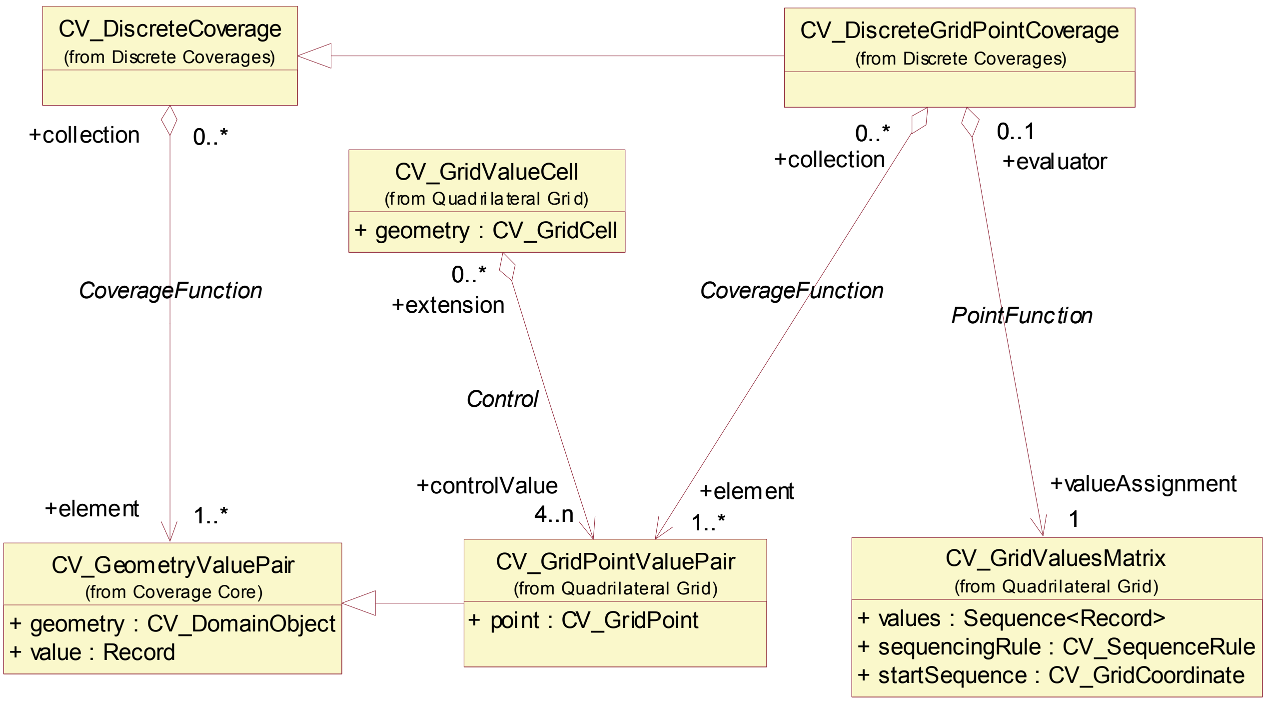


**Figure 10 –Discrete grid coverage**

A geometry value pair consists of a spatial, temporal or spatiotemporal object together with a record of feature attribute values. The value set for a classified data discrete coverage is represented as a collection of records with a common schema. The geometric object and its associated record form a geometry value pair. The geometric object corresponds to the independent variable and the record of feature attributes corresponds to the dependent variable. The attribute *rangeType* of the object CV_Coverage describes the range of the coverage. This can be any value type appropriate for the classification system. The application schema for a particular classification system defines the record structure used to contain attribute values for that application system.

In a discrete coverage attributes are typically references to coded values in a data dictionary of classification types. A classification type corresponds to a feature type that is defined as part of a classification scheme. That is, the feature type is constrained to be part of the classification system that imposes some overall structure on the classification types. The structure can be organized in either an *a priori* or *a posteriori* manner as described in clause 5.4. Figure 11 shows the relationship of a classification attribute to a feature type. The data dictionary of classifiers may be held in a register as described in clause 6 below.

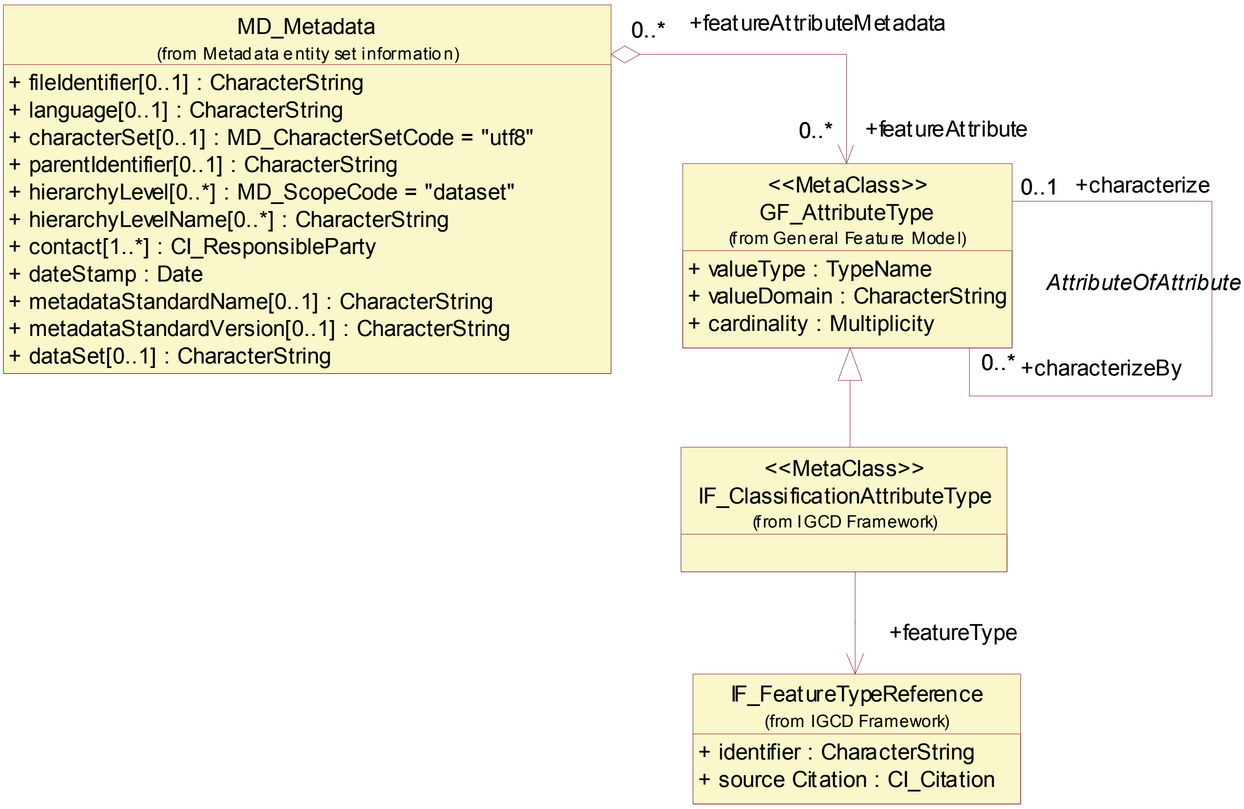


**Figure 11 –** Relationship of Classification attribute to feature type

## 5.6 A Classification Data Set

A set of classified data includes the description of a discrete coverage, together with associated metadata. Figure 12 illustrates an overview of a content model for classified discrete coverage data. This is specialization of Figure 11 from ISO 19129. Metadata elements consist of two types, those that describe the context of the data and those that describe the content of the data. The geometric structure and attribute data consists of Spatial Referencing, a value set of data elements and optionally some trype of systemic compression. Systemic compression is data compression that eliminates data that can not actually occur in the data set. An example would be a tiling scheme that permits data for areas only where data is possible. Georeferencing of coverage data is described in ISO 19129 clause 10.

The model in Figure 13 illustrates the relationship between discrete grid coverage data and associated metadata comprising a data set. The class IF_DiscreteGridCoverageData is a collection class that links the coverage to the metadata. A similar situation exists for other discrete coverage types where the coverage is associated with metadata in a data set.

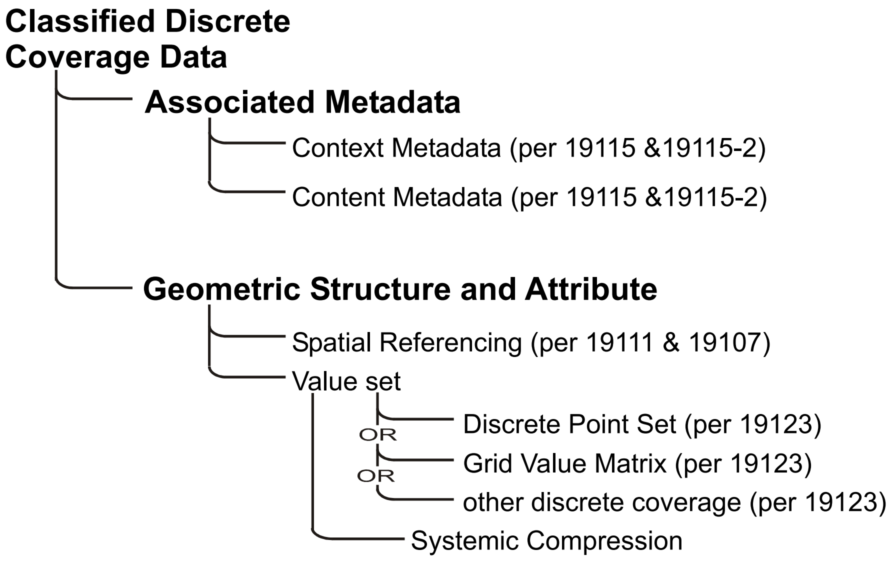


**Figure 12 –** Overview of a content model for classified discrete coverage data

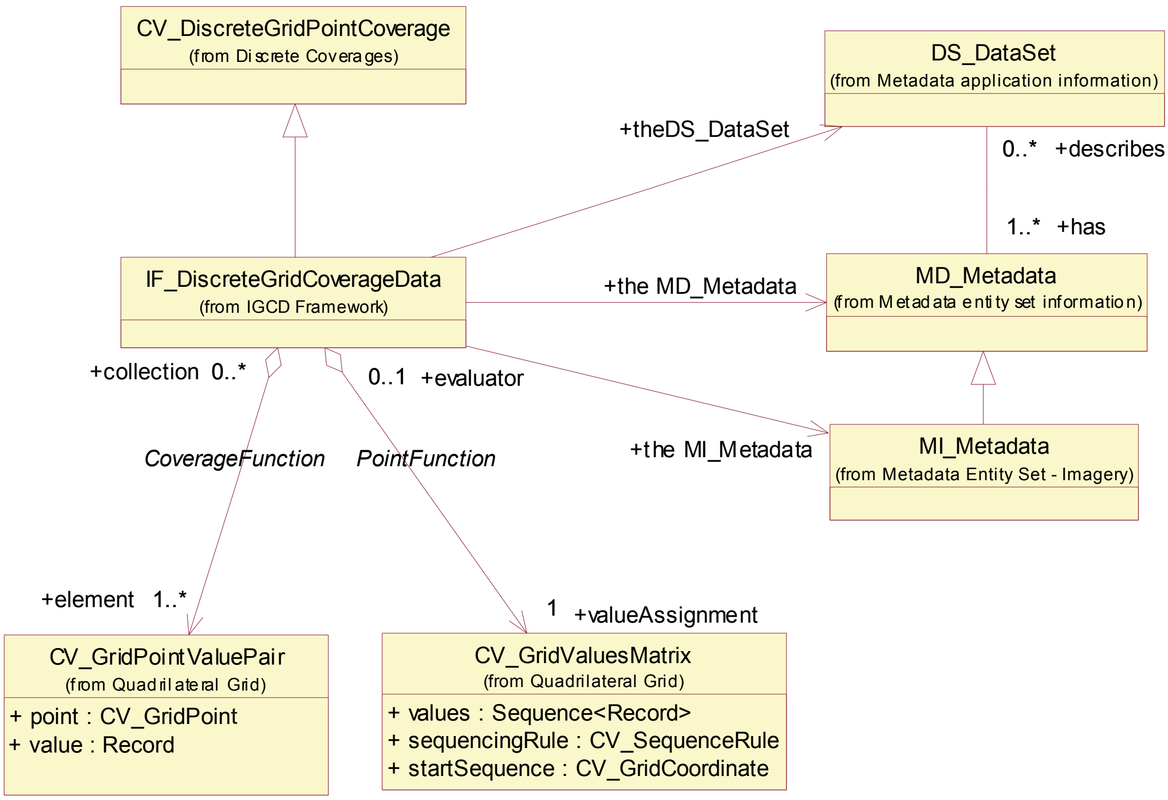


**Figure 13 –** Classification data set content elements for a discrete grid coverage

# 6 Management of Classifiers

## 6.1 Introduction

A classification object is a subtype of feature attribute that is constrained to work within a particular classification scheme. The process of establishing a classification system subdivides the attribute range of a discrete coverage. Like a feature attribute, a classification may be predefined with the definition stored within a data dictionary. The data dictionary may contain all of the classifiers available within the classification scheme. Over time the new classifiers may be added to the classification scheme and the definitions or criteria of certain classifiers may be modified. An appropriate manner of managing such changes is through the process of registration. This is analogous to the registration of feature and attribute definitions in a feature data dictionary.

Classification object are described by classifiers that have names, definitions and identifiers (codes). These can be registered. In addition classification objects may have rules that relate them to other classification objects. For example the classification "Savana" in the UN LCCS is dominant grass with sparse trees and or sparse shrubs. That is, the classification requires both grass and trees or shrubs with the grass dominant. There is a relationship of dominance between the grass and the other elements. There may also be rules relating geometry or scale to classification objects. For example if an object is too small it may not be possible to represent it in a data set at a given scale. However it may be desirable to combine two classifications into a mixed classification to show the existance of the material that is otherwise not possible to represent. For example a 1 km square on the ground will appear as a 1 cm square at 1:100,000. This could be easily represented. However the same 1 km square on the ground will appear as a 1 mm square on a 1:1,000,000 map and could be beneath the threshold for creation of a separate area. If an object is less than miniminal mappable area one can create a mixed classification i.e. A|B mix of A and B with A dominant and B at least a threshold percentage.

Classification schemes can become very complex. For example the UN FAO LCCS is based on plant physionomy and all of the rules of that dicipline are inherint in the classification scheme. Other classification schemes in other diciplines may be simpler or more complex. The rules relating classification objects may relate to the heirachy of the classification scheme, or to the relationship between classifiers or to spatial aspects. For simple classification schemes it may be possible to describe the rules relating classifiers in descrfiptive text. In more complex classification schemes the rules may be described in a form that can be processed automatically such as a programming language. An example of such a programming language is the logical and a declarative programming language called Prolog. Ref: [8]. The name *Prolog* is derived from *programmation en logique.*

## 6.2 Concept of a data dictionary register for a classification scheme

A feature data dictionary is described in ISO 19126 as a set of independent specifications of feature types and attribute types. In a classification system classification objects represent the partitioning of the range (attribute space) of a discrete coverage. There is no clear demarcation that indicates the limit to what is a feature. Classification objects are in effect features where the partitioning of the attribute space has added specificity to the definition of the feature. A classifier is used to specify a classification object. A classifier is a definition or rule that may be used to establish a classification object. The set of classifiers form a data dictionary and may be held in a register.

Some classifiers consist of only a definition that describes the type of classification object, whereas, other classifiers contain code lists of allowed values or ranges of quantities represented as numeric values. Where a quantity is represented as a numeric value the units of measure must also be specified for that quantity.

## 6.3 Management of Classifiers through Registration

Classification systems may be relatively fixed a priori heirachical structures or they may be very flexible and complex *a postierori* structures, but in both cases they are specific to the application area for which they were defined. Over time additional classifiers may be added to the classification system or the existing classifiers may need to be modified. This type of maintenance of a set of classifiers lends itself to registration.

Registration has other indirect advantages. The overall structure of a classification system and the schema for the register may be standardized, but the specific details of the classifiers are held in the register. This permits flexibility and the handling of a large number of classifiers and resultant classification object class types. It also allows for ownership of the register by the information community supporting the application area. For example, part 2 of this standard describes the structure of the Land Cover Classification System of the UN FAO and the schema for the registration of classifiers for the UN FAO LCCS; however the ownership and maintenance of the register of classifiers is managed by the UN FAO.

## 6.4 Register structure

### 6.4.1 Elements of a register

Registers provide a basis for the flexible management of classifiers. ISO 19135 specifies how registers shall be managed and the information that shall be included in any proposal for registration of an item of geographic information. A register of classifiers complies with ISO 19135.

A register of classifiers is a multi-part register that may include specifications of:

a. classifier - code, name, and definition (where the definition may reference enumerated values or numeric values with associated units of measure) and modifiers (attributes);
b. enumerant values;
c. units of measure;
d. rules describing the relasionship between classification or the relasionship of classification objects to geometry.

Additionally, each item also includes information necessary to manage that item, *e.g.,* item identifier, management status, and possibly information about relationships to items in external specifications.

### 6.4.2 Register Schema

The classifier register schema is derived from the register schema in ISO 19135 and is shown in Figure 14. The register schema is extended to include a subtype of RE_Register for a Classifier register (CR_ClassifierRegister), a subtype of RE_RegisteredItem corresponding to a Classifier item (CR_ClassifierItem) and a subtype of RE_ItemClass corresponding to a Classifier item class (CR_ClassifierItemClass). This extension is done in a manner parallel to that for feature items described in ISO 19126.

The class CR_ClassifierRegister has attributes that describe the classifier register as a whole. It inherits basic attributes from the class RE_Register from ISO 19135 and adds three additional attributes. These attributes are equivalent to those required to describe a Feature Information Register as described in ISO 19126 and are taken from that source. This is illustrated in Figure 15 below.

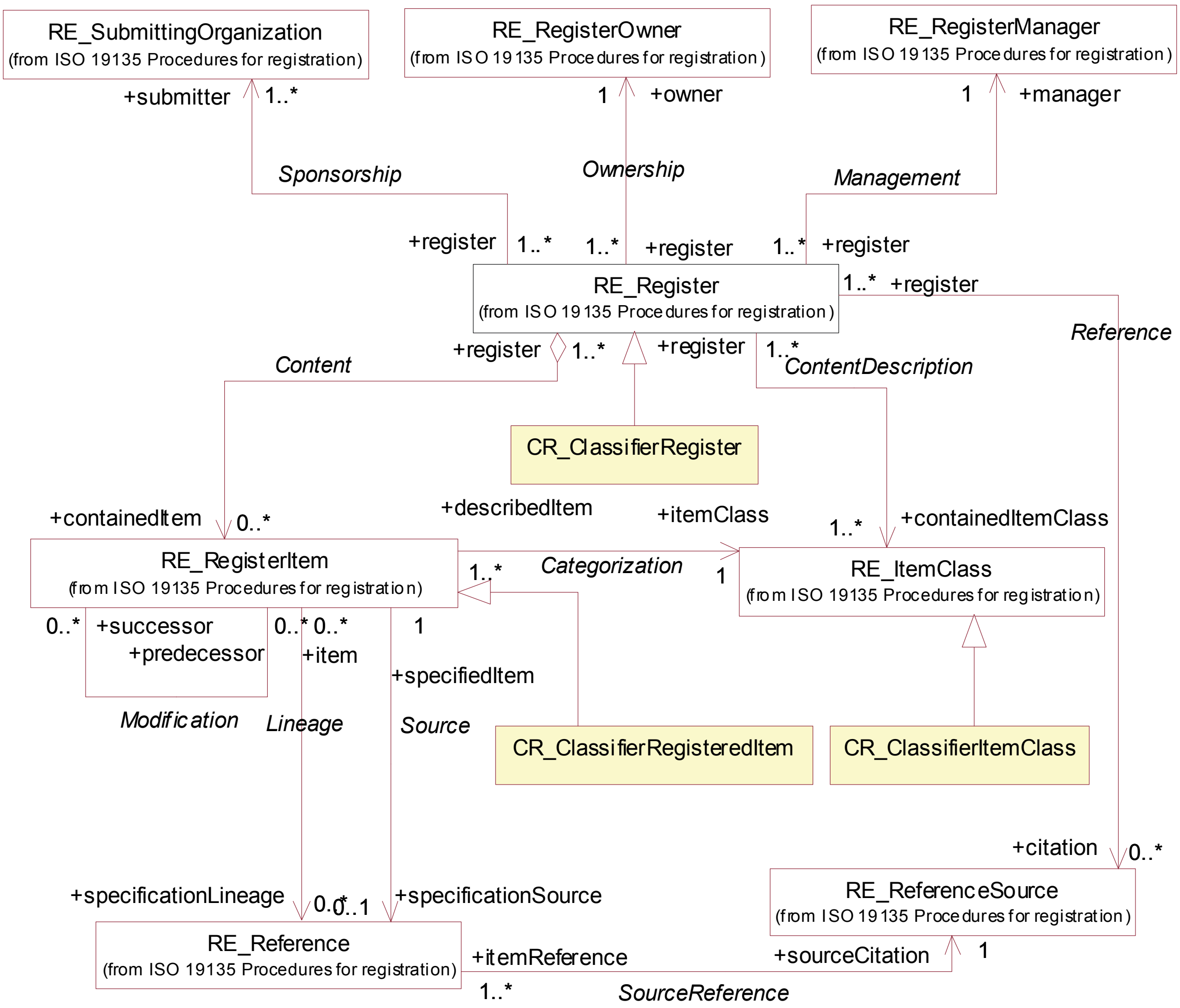


**Figure 14 –** Classification register schema showing added classes

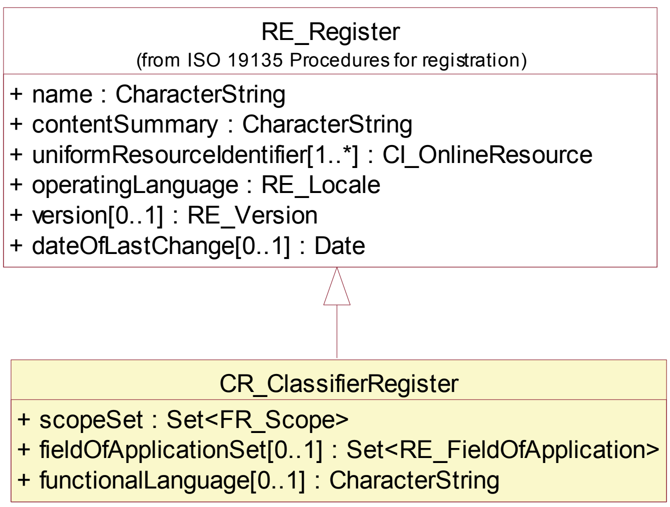


**Figure 15 –** Classifier Register

The class CR_ClassifierItemClass specifies information about a classifier item class in a classifier register. It is the description of what can be registered. The items that may be registered are represented as subclasses of CR_ClassifiedItemClass, and consist of a CR_ClassifierClass, a CR_UnitOfMeasureClass, CR_AttributeListedValueClass and CR_ClassificationRules. The classes CR_UnitOfMeasureClass and CR_AttributeListedValueClass are equivalent to FR_ UnitOfMeasureClass and FR_AttributeListedValueClass described in ISO 19126 and are shown as inheriting from those classes. Since a Classifier is used to partition the attribute space (range) of a discrete coverage it is related to a feature attribute. This is shown by the relation "describes" where the CR_ClassifiedItemClass is described in terms of one or more specific feature attributes. CR_ClassificationRulesClass describes the relasionship between classifiers or to geometry. This is done by reference to the FR_FeatureAssociationClass. This is illustrated in Figure 16 below.

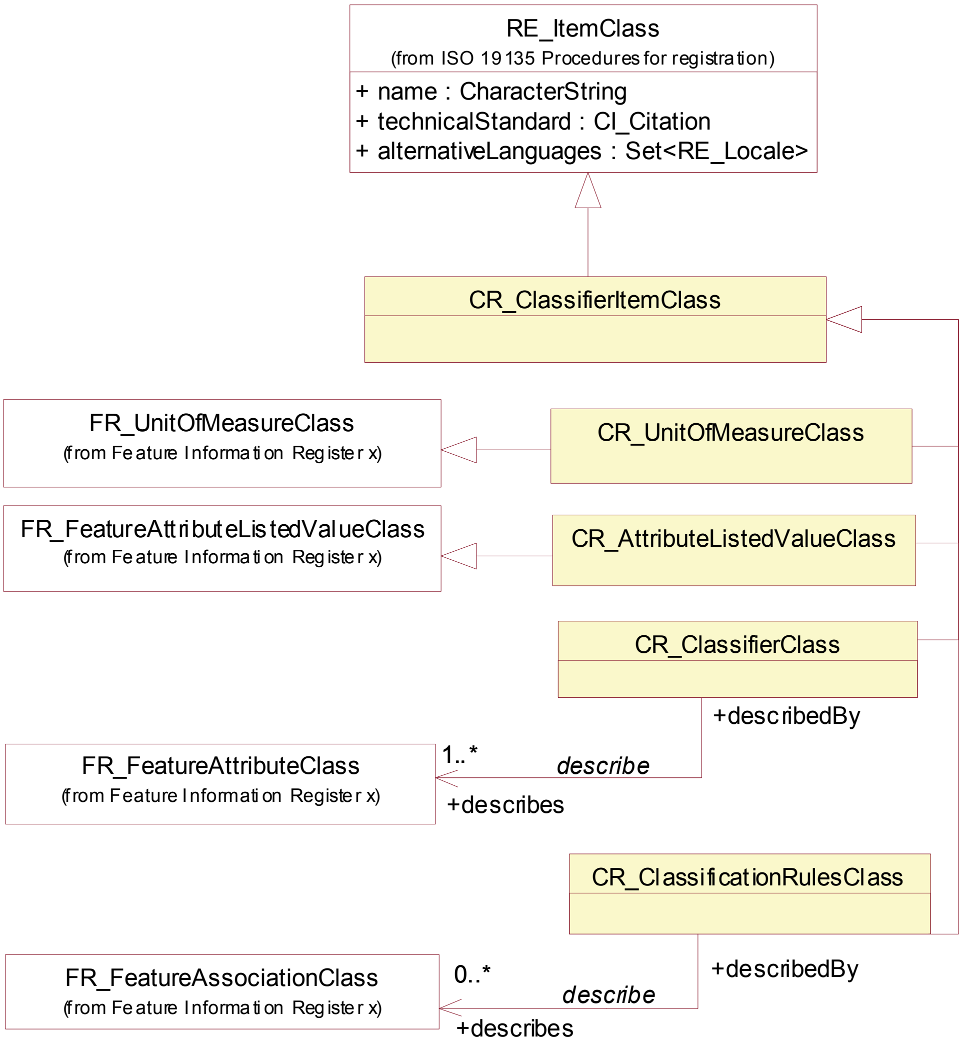


**Figure 16 –** Classifier Item Class

The class CR_ClassifierRegisteredItem specifies information about a item in the classifier register. It is the description of the actual item registered. It adds two additional attributes to RE_RegisteredItem. These attributes are equivalent to those required to describe a Feature Information Register as described in ISO 19126 and permit a numeric code and an alpha code. The registered items are represented as subclasses of CR_ClassifierRegisteredItem, and consist of a CR_Classifier, a CR_UnitOfMeasure, CR_AttributeListedValue and CR_ClassificationRules. The classes CR_UnitOfMeasure and CR_AttributeListedValue are equivalent to FR_ UnitOfMeasure and FR_AttributeListedValue described in ISO 19126 and are shown as inheriting from those classes. The class CR_Classifier is a description of a classifier. It inherits the attributes it requires to describe the classifier from RE_RegisteredItem. It is related to FR_FeatureAttribute in order to utalize specific types of feature attributes such as numeric attributes or enumerations in its description. This is shown by the relationship "uses". The class CR_ClassificationRules is a description of a set of rules that relate classifiers or to geometry. It is related to FR_FeatureAssociations by the relatiuonship "uses". This is illustrated in Figure 17 below.

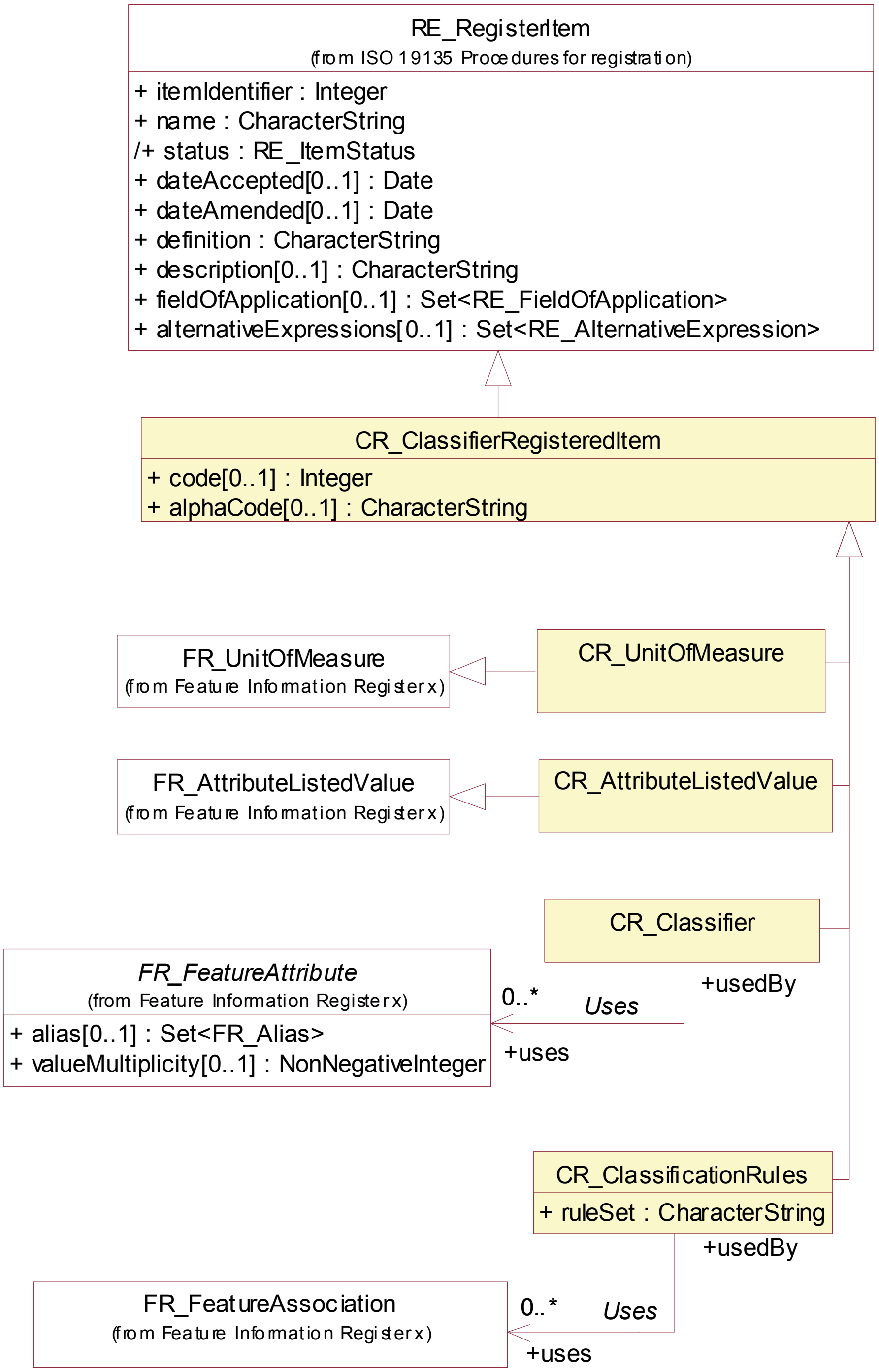


**Figure 17 –** Classifier Registered Item

# Annex A
(normative)

# Abstract test suite

## A.1 Introduction

This normative annex presents the abstract test suite for evaluating conformance to this International Standard. The abstract test suite contains a test module for a Classification System (A.2), and a test module for a register of classifiers (A.3).

## A.2 Conformance of a classification system

### A.2.1 Discrete surface coverage classification system

a) Test Purpose: Verify that an application schema or profile satisfies the requirements that it instantiates CV_DiscreteCoverage and that it instantiates the class CV_SurfaceValuePair with the attributes *value* and *geometry* with the geometry attribute set to *GM_Surface*.

b) Test Method: Inspect the documentation of the application schema or profile.

c) Reference: ISO 191xx-1  clause 5.5.

d) Test Type: Capability.

### A.2.2 Discrete grid coverage classification system

a) Test Purpose: Verify that an application schema or profile satisfies the requirements that it instantiates CV_DiscreteCoverage and that it instantiates the class CV_GridPointValuePair with the attributes *point* set to *CV_GridPoint, and also* instantiates the class CV_GridValuesMatrix with the attributes *values, sequenceRule* and *startSequence*.

b) Test Method: Inspect the documentation of the application schema or profile.

c) Reference: ISO 191xx-1 clause 5.5.

d) Test Type: Capability.

### A.2.3 Constraint on feature types in a classification system

a) Test Purpose: Verify that an application schema or profile constrains feature types to those established as part of the classification system

b) Test Method: Inspect the set of feature types to ensure that they correspond to those permityted within the classification system by ensuring that they can be described in terms of the classifiers that define the classification system.

e) Reference: ISO 191xx-1 clause 5.5.

c) Test Type: Capability.

## A.3 Conformance of a register of classifiers

### A.3.1 Classifier register schema

a) Test Purpose: Verify that a register of classifiers for a classification system complies with the register schema defined in ISO 19135 and instantiates the additional classes CV_ClassifierRegister, CR_ClassifierRegisteredItem and CR_ClassifierItemClass.

b) Test Method: Inspect the documentation of the register schema.

c) Reference: ISO 191xx-1 clause 6.4.2.

d) Test Type: Capability.

 

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